41. *On the Diffraction of Cathode Rays by Powdered Crystals.*

By Toshinosuke MUTO and Tasaburo YAMAGUTI.

Physical Institute, Tokyo Imperial University.

(Rec. March 1, 1929. Comm. by T. TERADA, M.I.A., March 12, 1929.)

The object of the present investigation was to extend G. P. Thomson's experiment¹⁾ on the diffraction of homogeneous cathode rays by thin films of metals and celluloid to any substance which can be obtained in powdered form.²⁾ The apparatus which had been employed by Mr. Kikuchi³⁾ in his experiment on mica was at our disposal and all the experimental procedure was the same as before, except the preparation of the specimen which may be worth describing in detail.

At first trial, a thin celluloid film was used for the means of suspending a thin layer of the crystalline powder. The powder was stirred up in a closed vessel and the fine smoky particles suspended in air were slowly precipitated on the film, through which the rays were to be passed. In the diffraction pattern thus obtained, the effect produced by the celluloid film was superposed on that of the crystalline powder and the latter was often blurred by that of the former. A thin flake of mica was also tried in place of the celluloid film without success.

In the next trial, the powder was precipitated as above on a thin slice, about 40–50 μ thick, of the pith of a plant "*Tetrapanax papyrifer* K. Koch," whose common name in Japanese is *Tsūdatsuboku*.⁴⁾ The idea was that this material is very light and porous, and its slice forms a fine net consisting of the walls of the vegetable cells, so that the powder may be suspended in the interstices. In this case the result was more satisfactory. The diffraction due to the pith was not the type of regular haloes which would mask the effect of the crystalline powder, and several discrete diffraction rings due to the latter were observable.

On examining by a microscope the distribution of the powder in the vegetable net, it was found that in the sample, with which a good

1) G.P. Thomson, Proc. Roy. Soc. A, **117** (1928), 600; **119** (1928), 651.

2) In a recent number of Comptes Rendues [**188** (1929), 244], which we have just received, a similar experiment is described by M. Pontes. The present experiment was, however, carried out quite independently.

3) S. Kikuchi, Jap. Jour. Phys., **5** (1928), 83.

4) We are indebted to Prof. K. Fujii, the Botanical Institute, Tokyo Imperial University, for his kind help in preparing the samples.

pattern was obtained, the microcrystalline particles were deposited only on the thread of the net and not in the interstices as had been expected.

Thus, at last the following device was adopted. Taking the fine viscid thread of spider's web, short lengths of it were stretched on a frame closely side by side and the powder was deposited on it as described above. A good pattern was obtained by this device. The effect due to the web only was slight, being somewhat similar in type to that of the vegetable pith and scarcely disturbed the pure effect due to the crystalline powder.

In Fig. 1 is shown one of the patterns obtained in this way using the powder of magnesium oxide, the velocity of the cathode rays being 50 in terms of kilovolts. Similar patterns were obtained from graphite powder. In Tables I and II are given the results of the experiment in comparison with those of X-ray analysis.

$$\lambda = 0.054_3 \text{ A.}$$

Fig. 1.

Table I. (MgO)

X-Rays (Wyckoff)			Cathode Rays	
Indices of Planes	Intensities	Spacings	Intensities	Spacings
111	2	2.43 A.	V W	2.46 A.
200	10	2.10	V S	2.11
220	9	1.48	S	1.49
113	2	1.27	—	—
222	5	1.21	W	1.21
400	3	1.05	—	—
133	$\frac{1}{2}$	0.960	—	—
240	6	0.937	W	0.941
224	5	0.856	V W	0.853
440	$\frac{1}{2}$	0.741	—	—
600	1	0.698	—	—

Table II. (Graphite)

X-Rays (H. and M.)			Cathode Rays	
Indices of Planes	Intensities	Spacings	Intensities	Spacings
002	s st	3.41 A.	—	—
110	m st	2.16	—	—
111	st	2.06	V S	2.04 A.
004	st	1.74	—	—
203	m st	1.56	V W	1.58
310	m st	1.24	—	—
312	m st	1.16	S	1.19
006	m st	1.14	—	—
{206} {024}	m st	0.997	W	0.996
{008} {405}	m st	0.846	—	—
316	st	0.826	V W	0.823

V W=very weak, W=weak, S=strong, V S=very strong.

The spacings of reflecting planes given in the second columns are the mean values calculated from the radii of rings in the photograms taken with the rays of different wave-lengths ranging from 0.044 to 0.062 A. The X-ray data are due to Wyckoff¹⁾ for MgO and to Hassel and Mark²⁾ for graphite. As will be seen from the tables, the values of spacings obtained by means of cathode- and X-rays are in good accord. Moreover, a fair agreement will be found in the relative intensities of the rings.³⁾

In conclusion, the authors wish to express their best thanks to Professor S. Nishikawa for his continued interest during the work and also to Mr. S. Kikuchi for his kind advices in the early course of the experiment.

1) R. W. G. Wyckoff, *The Structure of Crystals* (1924), 189.

2) O. Hassel and H. Mark, *ZS. f. Phys.* **25** (1924), 317.

3) It may seem that in the case of graphite the agreement is not good. There is, however, a discrepancy of the same degree among the X-ray intensities of different investigators.